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THE EPA TESTING PROGRAM FOR COMPONENTS OF TREATMENT, STORAGE, AND DISPOSAL FACILITIES

by

Rober ndreth
U.S. Environmenta: rotection Agency
Hazardous Waste Engineering Research Laboratory
Cincinnati, Ohio 45268

HAZARDOUS WASTE ENGINEERING RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OH 45268

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16. ABSTRACT

This paper discusses some of the tests required by the Agency to evaluate the adequacy of liner and leachate collection materials. These laboratory tests subject the candidate materials to the physical, biological, and chemical stresses that are intended to duplicate conditions found in a treatment, storage, or disposal facility (TSDF). Some unresolved testing conerns are also discussed.

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INTRODUCTION

Land disposal continues to be a popular and economical method for disposing of hazardous wastes. Though poor practices in the past have led to significant environmental problems, today's properly designed, constructed, and operated land disposal facility represent a major step forward toward ensuring that waste will not be a source of health and environmental concern for many decades. In November 1984, the Hazardous and Solid Waste Amendments (HSWA) of 1984 were signed into law. Liners and leachate collection components are required for surface impoundments and waste piles under Section 3004(O) and 3015 of the Resource Conservation and Recovery Act (RCRA) as amended by the HSWA minimum technological requirements for hazardous waste landfills. Among these provisions are:(1)

- o New units and lateral expansions and replacements including all types of treatment, storage and disposal facilities, must be double-lined and must have leachate collection systems, and
- o New units and lateral expansions and replacements at interim-status waste piles must meet the requirements for single liners and leachate collection.

The U.S. Environmental Protection Agency (EPA) has published two documents establishing minimum technology guidance on single and double liner systems.(2),(3) These documents provide guidance for owners/operators and regulatory personnel on design, construction, and operation of systems believed by the Agency to meet the requirements of Sections 264.221(a), 264,251(a), and 264.301(a) of RCRA. This guidance also identifies specifications that can be used by owners/operators to meet the above requirements for HSWA.

This paper discusses some of the tests required by the Agency to evaluate the adequacy of liner and leachate collection materials. These laboratory tests subject the candidate materials to the physical, biological, and chemical stresses that are intended to duplicate conditions found in a treatment, storage, or disposal facility (TSDF). Some unresolved testing concerns are also discussed.

CURRENT TESTING PROTOCOLS

The more common testing programs for liners and leachate collection components evaluate their physical properties before and after exposure to the liquids being contained.

Method 9090

Method 9090 incorporates an elevated temperature to accelerate the potential chemical attack.(4) Physical properties are measured before exposure and 1, 2, 3, and 4 months after exposure. Data from exposures at room temperature and at elevated temperature are compared to detect any change or rate of change in the physical property values caused by exposure. Rejection criteria values based on the amount of change cannot be given since the change affects the performance of different materials in different ways and to different degrees.

The use of Method 9090 by testing and development companies has generated questions regarding materials testing. Among these questions are the following:

(1) Should environmental stress cracking (ESC) be added to Method 9090?

(2) Should the leachate be changed during the immersion period?

(3) What other liner and leachate collection system components are required by current regulations to be compatible with wastes?

The Agency has offered supplementary guidance on these questions in Directive No. 9480.00-13.(5)

-Including Environmental Stress Crack

Testing for ESC is not currently included in Method 9090. However, recently reviewed data and discussions with technical experts, including polymer manufacturers, have re-emphasied the need to require an ESC test for crystalline and semicrystalline polymeric membrane liners. Stress cracking tests such as ASTM A 1693-70(6) accelerate physical failure by starting with a standard incision and measuring its propagation. The Standard warns against using the results of ESC tests in direct engineering applications, since they do not quantitatively determine the effect of exposure on material strength. Though other tests have been suggested to evaluate ESC, the use of ASTM D-1693-70 by the manufacturers and testing companies remains the test of choice due to the large data base developed over the years. The Agency is reviewing Method 9090 and is considering ESC test methods. Until specific ESC tests are developed to simulate conditions at a TSDF, the Agency encourages the owner/operator to conduct the D-1693 test.

-Changing the Leachates

Changing of the leachates during the exposure of candidate materials is another issue addressed by Directive No. 9480.00-13. The question centers around the concern that some of the constituents in the leachate may be volatile or have an affinity for the candidate materials being tested. Since most TSDF's release leachate that is generally consistent in chemical composition, the owner/operator must assure that the chemical composition of the leachate used for testing remains relatively constant during the test to provide a representative environment for specimens being immersed. The owner/operator must also attempt to seal the immersion vessel as tightly as possible to prevent a loss of volatiles. In addition, the concentrations of leachate chemicals that are suspected to affect the sample (e.g., aliphatic and halogenated hydrocarbons) must be checked during the exposure time to ensure that the leachate composition does not change significantly. If the constitutents change

significantly, the owner/operator should replenish the leachate frequently enough to assure that the liner samples are experiencing exposure conditions similar to those in the field.

-Chemical Compatibility of Other System Components

Directive No. 9480.00-13 also addresses other system components that need to be evaluated for chemical compatibility. Section 264.301(a)(2) of RCRA requires that the leachate collection and removal system be constructed of materials that are chemically resistant to the waste managed at the TSDF. Suggested general procedures for meeting this requirement include testing of plastic piping, geotextiles, and earthen materials, as follows:

1. Plastic piping - Plastic piping should be prepared for strength testing per ASTM D 2412 or its equivalent. At least one prepared sample should be subjected to the same immersion test as performed on the liner material (e.g., the immersion test outlined in Method 9090). After the immersion test, the pipe sample should be dried (per Method 9090) and subjected to a strength test (see especially ASTM D 2412, paragraphs 6-9). Testing of a control specimen (a sample not subjected to the immersion test) should be performed. A report should be prepared similar to that outlined in ASTM D 2412 paragraph 11 (including 11.1.7 and 11.1.9) comparing the test results of the immersed and control samples.

2. Geotextiles - Geotextiles can be used to perform any of three major functions in the land disposal unit: (1) protection of the flexible membrane liner, (2) filtration, or (3) transmission of liquid (water or leachate). Testing procedures for a given geotextile depend on its function. When the geotextile is used either as a filter or as a protective medium for the flexible membrane liner, it should receive immersion testing like that for flexible membrane liners. After any immersed specimens are dried, they and the identical control specimen(s) should be subjected to the ASTM D 1682 grab strength test and the ASTM D 751 puncture strength test to determine whether a significant loss of strength has occurred.

   Synthetic materials used for leachate drainage (e.g., nets) should also be immersed in the expected waste/leachate. Following immersion, both a control specimen and the immersed specimen should be tested for in-plane transmissivity. No ASTM method presently exists to evaluate in-plane transmissivity, but the Federal Highway Administration's Geotextile Engineering Manual references a technique by Koerner and Bove.(7) This or another method can be used to compare the in-plane transmissivity of the immersed specimen with that of a control specimen.

   The transmissivity test should include the following conditions:

   (1) The pressure exerted on the geotextile should be at least 1.5 times the maximum expected pressure to be experienced during the active life and post-closure period of the unit.

   (2) The geotextile should be placed in the apparatus under expected field conditions--that is, both sides of the geotextile should be placed against the materials experienced in the field (e.g., soil, sand, gravel, flexible membrane liner, or other geotextile).

3. Earthen materials - When rock or gravel is used as drainage material in the leachate collection system, the owner/operator should verify that the mineral content of the rock is compatible with the waste/leachate mixture. The owner/operator will need to demonstrate that the rock will not be dissolved or form a precipitate that would clog the leachate collection system.

Soil used as a liner or a component of a composite should be subjected to EPA Method 9100 using the expected leachate to determine its effect on the hydraulic conductivity of the compacted, low-permeability soil. The owner/operator may use the fixed-wail or triaxial test.

A wide range of compositions and constructions has been reported for the same generic liner.(8) This range may be the result of changes made in the basic formulations to meet a specific exposure requirement, changes made in the base polymer as a result of manufacturing processes, or other factors. Regardless of the reason for the change, generic names are insufficient to identify a liner material. This fact becomes extremely important when materials used in TSDF's have had extensive compatibility testing and the design is based on the properties of a specific material. The potential for change in composition between the time of testing and construction forms the basis for a "fingerprint" test procedure. A procedure outlined by Haxo(9) can provide valuable information to characterize and identify a specific material. The information then serves as a baseline for monitoring the effects of exposure on the liner and helps assess the aggressive nature of leachate constituents. The recommended procedure includes the following analyses for liners before and after exposure: volatiles, ash, extractables, gas chromatography, thermogravimetric analysis, differential scanning calorimetry (crystalline materials), and specific gravity. The results of these analyses can be used to demonstrate that the liner material tested for chemical compatibility in Method 9090 is the same as that being installed at a TSDF--even if the testing and installation are separated by a significant time period. The results could also be compared with the results of period similar tests of exposure coupons to determine whether changes in the liner properties are occurring during laboratory exposure to leachate. Thus the liner performance could be monitored for early warning of potential liner failure. The results of the fingerprint analysis could also be used to identify aggressive leachate constitutents that are attacking the liner. Such constituents could then be removed from the waste stream.

FUTURE TESTING

Recognizing that no laboratory test fully duplicates field exposure, the Agency is constantly reviewing and developing procedures to produce laboratory results that will correlate with field performance. The ideal procedure would be to have a short-term test that predicts the performance for several hundred years. The performance would be predicted for both chemical resistance and physical stresses to which the liner components would be subjected during the active life of the facility and post-closure period.

Some consideration has been given to stressing components during the Method 9090 test procedure. Harwell Laboratory(10) used elevated temperature and weighted sample specimens to produce a stress condition during chemical compatibility testing. Steffen(11) has suggested that field conditions are better simulated when the component is stressed during exposure. Since the material actually experiences stress e.g., during settlement or placement of the wastes, during the site life, it

is logical to add this condition to current procedures. Details of stressing the liner materials during exposure must still be developed, and additional research is required to interpret the results.

After the initial disposal unit at a given site has been tested by Method 9090 coupon testing(12) may be used as an alternative to Test Method 9090 for subsequent disposal units built at the site, providing the waste characteristics do not change. Exposure coupons in the leachate sump area of landfills or directly in surface impoundments are probably more representative of actual field conditions than most laboratory tests. However, the large number of sample specimens for the liner and drainage collection materials will almost certainly require a large area for testing. Also, the agitation of the leachate in the sump must be taken into account. Since the temperature in the sump area will most likely be near ground temperature (i.e., approximately 55°F), the time of sample exposure should be extended longer than the exposure time of Method 9090. Method 9090 currently does not require exposure temperatures of 55°F because longer exposure times would be required. Though some work has been completed on acceleration of aging with increased temperatures, few data are available on the effects of lowering the temperature and reducing the time required to produce a given change at these temperatures.

Concern exists over the quality of the data that are being submitted to EPA for review of Part B permits. Decisions need to be made about developing and running a laboratory testing certification program. Standards are not generally available to perform round-robin tests or to evaluate variances in test procedures or between laboratories. Though the Agency has limited resources for this research, EPA remains very interested in the subject area.

Probably the single most important issue raised in the overall testing program--and one about which the Agency is very concerned--is that of data interpretation. Because only a few individuals can interpret the data accurately and predict chemical compatibility based on short-term exposures, the Agency has assembled some of this expertise in a computer system. This system can be used by both owners/operators and the regulatory community. The system is part of an artificial intelligence program made up of discrete computer-based, user-friendly programs that incorporate the knowledge, experience, and expertise of those individuals who analyze TSDF components. The liner chemical compatibility system(13) is now being readied for verification testing. The success of this project will provide consistent permit reviews, save time and money, and synthesize large amounts of expert, heuristic knowledge into a form that can help determine the adequacy of various technical interpretations and best engineering judgments.

SUMMARY AND CONCLUSIONS

Testing of liners and leachate collection components should be performed to duplicate the conditions of actual containment systems. EPA has presented test protocols that represent the conditions to which construction materials will be subjected. The Agency continuously reviews these protocols and develops new procedures to improve the ability to predict what will actually happen in the environment.

Current test protocols include Method 9090, which uses elevated temperature to accelerate the potential chemical attack. Tests for chemical compatibility should be performed on liners as well as other system components, including plastic piping, geotextiles, and earthen materials. A "fingerprinting" procedure can provide valuable information for characterizing and identifying a specific material.

Future testing may include an environmental stress crack test for crystalline and semicrystalline polymeric membrane liners stressing of components during the Method 9090 test, coupon testing at certain sites, and a computer system that incorporates the knowledge, experience, and expertise of individuals who analyse TSDF components.

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